出國報告(出國類別：研討會)

參加「APEC 應用遙測與地理資訊系統於作物生長訓練課程」出國報告

服務機關：行政院農業委員會農糧署

姓名職稱：糧食產業組黃淑娟技正

派赴國家：中國大陸

出國期間：102 年 8 月 26 日至 102 年 8 月 31 日

報告日期：102 年 9 月 27 日

摘要

中國農業科學院農業資源與農業區劃研究所舉辦「APEC 應用遙測與地理資訊系統於作物生長訓練課程」(Training Course on the Application of Remote Sensing and GIS in Crop Production)，提供 APEC 各經濟體及全球一個專業知識經驗交流及分享的平台，今年接續去年研討會成果議題，專注在應用遙測與地理資訊系統於計算和預測作物面積與產量面的技術研討訓練及推廣。本研討會邀請 12 個 APEC 經濟體約 34 人及大陸學研界總計約 110 人參加。研討會課程深入探討資料蒐集、模式建立及決策支援方法，有效提升各經濟體在監測作物面積、預測作物生長情形及作物生長適宜性之技術能力，並促進經濟體間遙感技術國際合作契機，相信亦有助於確保糧食安全。

目錄

參加「APEC 應用遙測與地理資訊系統於作物生長訓練課程」出國報告

壹、目的

遙測與地理資訊系統正型塑新的經濟活動，特別是在農業領域，該等農業創新技術運用，對農業永續及糧食安全有重大影響。APEC 經濟體在此領域已具備專業知識與成功經驗，APEC 農業技術合作工作小組(ATCWG)主事國中國大陸爲提供 APEC 各經濟體及全球一個專業知識經驗交流及分享的平台，自去(2012)年於北京舉辦研討會「the workshop on the application of Remote Sensing and GIS on crops productivity among APEC Economies 」，專注在主要糧食或經濟作物生產力，今 (2013) 年則接續延伸舉辦「Training Course on the Application of Remote Sensing and GIS in Crop Production」，重點在應用遙測與地理資訊系統於計算和預測作物面積與產量面的技術研討訓練及推廣。我國藉由參與此訓練課程與各經濟體進行經驗交流，以瞭解各經濟體在作物生產方面的技術應用與最新研究進展，擴展與經濟體間進一步的交流與合作機會。課程主題包括：

1. 遙測圖資準備(影像獲取、影像處理及糾正)
2. 利用遙測與地理資訊系統取得作物空間分布及生產面積之方法與模型
3. 利用遙測與地理資訊系統實現作物生長預測之方法與模型(包含產量與空間結構)
4. 利用遙測與地理資訊系統監測天然災害之方法與模型(旱災、寒害、病虫害)

貳、過程

一、行程及紀要

出國期間：102 年 8 月 26 日至 102 年 8 月 31 日，共計 6 天。行程如下：

- 8 月 26 日啓程，自桃園國際機場出發至中國大陸北京。

- 8 月 27 日參加研討會訓練課程，並口頭簡報台灣經驗。
- 8 月 28 日參加研討會訓練課程。
- 8 月 29 日參加研討會訓練課程。
- 8 月 30 日參訪行程。
- 8 月 31 日返程自中國大陸北京。

二、研討會訓練課程及內容

研討會於北京中苑賓館進行，計有來自台灣(中華台北)、澳洲、智利、中國大陸、印尼、馬來西亞、墨西哥、秘魯、菲律賓、泰國、美國、越南等 12 個 APEC 經濟體代表約 34 人及大陸學研界總計約 110 人與會。台灣(中華台北)與會人員為國立中央大學太空及遙測研究中心陳繼藩主任擔任專家學者及行政院農業委員會農糧署黃淑娟技正。

會議於 8 月 27 日(星期二)開始，由會議主辦單位中國農業科學院農業資源與農業區劃研究所徐明剛副所長主持，邀請中國農業科學院唐華俊副院長、財政部行政政法司黃敏捷副處長及農業部國際司王維琴處長致開幕辭後正式開始。

訓練課程計畫以研討會型式，邀請各經濟體發表國內經驗及由專家學者發表學術論文，課程資料內容如下：

(一) 8 月 27 日(星期二)

1. 中國農業科學院農業資源與農業區劃研究所吳文斌博士報告：「全球變遷對中國農業生產制度的影響」
2. 美國國際糧食政策研究中心李曼博士報告：「中國土地利用變化與土壤碳匯的實證分析」
3. 中國林業科學院李增元教授報告：「中國與歐洲太空總署合作地球觀測龍計畫介紹」
4. 澳州昆士蘭政府 Andrew James Robson 博士報告：「利用遙測與 GIS 發展準確的區域至田間尺度產量預測-甘蔗及花生作物」
5. 菲律賓水稻研究中心 Eduardo Jimmy P.Quilang 博士報告：「菲律賓水稻遙感應

用」

6. 越南國家農業規劃與計畫研究所 Nguyen Thi Hong Anh 博士報告:「遙測技術應用於中部高地主要農作物面積統計及土地利用分布製圖」
7. 智利自然資源信息中心 Eugenio Gonzalez Aguiló 博士報告:「牧草乾旱保險指數設計先驅計畫」
8. 台灣農委會農糧署黃淑娟技正報告:「建立遙測農作物面積調查體系之探討」
9. 中國葉利民博士報告:「氣候變遷下中國糧食安全的未來政策」
10. 中國 Bai Linyan 博士報告:「環渤海地區城市發展與大氣環境變化」
11. 中國科學院遙感與數字地球研究所黃文江博士報告:「農作物病害遙感監測」
12. 中國農業科學院農業資源與農業區劃研究所黃青博士報告:「基於 MODIS-NDVI 多作物種植區萃取和作物生長監測」
13. 中國氣象局國家衛星氣象中心吳勝利博士報告:「氣象衛星風雲 3 號遙感偵測-雪」

(二) 8 月 28 日(星期三)

1. 馬來西亞農業部 Mohd Amiruddin Bin Rali 博士報告:「應用遙測及 GIS 於馬來西亞主要作物水稻及椰子生產力」
2. 墨西哥農業部 Noemí López González 博士報告:「SPOT 和 UAV 影像分析」
3. 秘魯農業部 Jorge Alcantara 博士報告:「利用空間分析於轉基因作物環境釋放危險分析及決策支援」
4. 澳州昆士蘭大學 Kasper Johansen 博士報告:「繪製香蕉植株分布以促進香蕉束頂病毒的耕鋤」
5. 菲律賓農業部 Xerxees R. Remorozo 博士報告:「利用 IT、GIS、資料倉儲及遙感探測加強農漁業損害及損失評估」
6. 智利自然資源信息中心 Eugenio Gonzalez Aguiló 博士報告:「利用空間技術及遙測技術於智利農業」
7. 秘魯農業部 Henry Saul Juarez Soto 先生報告:「馬鈴薯病蟲害空間風險評估」
8. 泰國土地發展局 Karika Kunta 博士報告:「應用 RS 及 GIS 於經濟作物土地使用分區」
9. 中國 Yang Guijun 先生報告:「定量遙感在精準農業中的研究與應用」

10. 中國農業科學院農業資源與農業區劃研究所高懋芳博士報告：「從熱遙感數據反演地表溫度」
11. 匈牙利 Márton DEÁK 先生報告：「EO-1 衛星海波影像的次像素植群分析」
12. 中國氣象局國家衛星氣象中心范錦龍博士報告：「利用低解析力衛星數據監測冰霜」
13. 中國農業科學院農業資源與農業區劃研究所任建強博士報告：「中國農業遙感監測系統之農作物估產」
14. 中國 Cao Qiwen 先生報告:「氣候及社經因子對土壤有機質空間時序變數的影響」
15. 中國農業部農業信息重點實驗室 Jiang Zhiwei 博士報告：「基於遙感數據同化技術的區域作物產量估測」
16. 中國 Sunliang 博士報告：「作物蒸散量的遙感估算」
17. 中國農業科學院農業資源與農業區劃研究所何英彬博士報告：「利用遙感及 GIS 於作物適宜性分析」

(三) 8 月 29 日(星期四)

1. 中華台北(台灣)中央大學太空及遙測研究中心陳繼藩主任報告：「一種基於生物氣候學的水稻作物監測」
2. 印尼農業土地資源研究及發展中心 Rizatus Shofiyati 博士報告：「印尼空間稻作生長監測及產量估測」
3. 泰國農業部農業經濟辦公室 Pornpun Hensawang 博士報告：「泰國作物生產預測」
4. 中國農業科學院農業資源與農業區劃研究所主辦人何英彬博士主持訓練課程終場討論及成果評估。

(四) 8 月 29 日(星期四)

參訪行程：

1. 中國農業科學院農業資源與農業區劃研究所所屬之農業部農業信息技術重點實驗室
2. 北京長城
3. 北京 798 文創藝術中心

三、課程內容重點摘述

本次研討會計有 33 篇報告，主題涵蓋影響作物生產之環境氣候因子如土壤濕度、土壤有機質、土壤固碳、地表溫度之農業資源監測；特定作物面積、單位產量及病蟲害之農作物生長遙測調查與監測；農業天然災害監測評估；土地使用分類與適宜性之遙測分類應用等。使用之遙測手段與方法非常多元，衛星影像資料種類有光學衛星、雷達衛星與氣象衛星等，影像資料來源視觀測物體及監測目標，光學影像從航拍高解析影像(辨別植株)、高解析度衛星影像 IKONOS、中高解析度衛星影像 SPOT5 (監測區域至植珠範圍)、中低解析度衛星影像 MODIS(250m，監測國家範圍)至低解析資源衛星資料 Landsat TM(監測全球範圍)等；雷達衛星資料如 SAR、ASAR、ALOS AVNIR-2、PALSAR、RADARSAT 等則被大量的引用以補光學衛星之不足；另氣象衛星如中國鳳凰 3 號 FY-3 已可支援農業監測應用。

由多篇報告中可知影像已被廣泛的使用於農業領域，多數國家都建有自己的衛星接收站，如中南美國家墨西哥亦報告建有自己農業專屬的衛星接收站(ERMEX NG)及發展無人飛機，影像使用趨勢為多來源(光學、雷達)、多尺度(不同解析度影像)及多時段之整合應用以獲取較佳之精確度，尤以 MODIS 光學影像與 SAR 雷達影像之融合技術為主要手段之一，另為由高解析光譜影像中萃取有效資訊或由像素中辨別部份種植情形(Pixel 像素大於耕地範圍)，sub-pixel 次像素之萃取亦為方法之一，此外作物曆、作物物候資料、作物模擬及 NDVI、EVI 等各類植生指數之篩選亦被廣泛應用。

此次研討會主辦單位邀請中華台北(台灣)中央大學太空及遙測研究中心陳繼藩主任專題報告：「A Phenology-Based Approach for Rice Crop Monitoring（一種基於生物氣候學的水稻作物監測）」，提出以生物物候學為基礎，參考作物種植曆的簡易多時序衛星影像產量推估方法，此方法利用粗解析度但有每日影像的 MODIS 衛星影像及中解析度 Landsat 7 衛星影像融合後計算 Enhanced Vegetation Index (EVI)及 Leaf Area Index(LAI)資料，經影像過濾處理，可篩選出稻作種植期、種植分布，並利用 EVI/LAI 比值建立稻作產量推估模式。針對耕地面積規模較小的亞洲地區，利用此融合後影像（30 m 空間解析度及 8 日時間解析度）有效提高了 MODIS 影像的應用價值。由於陳教教授提出之方法簡單新穎，各經濟體討論熱烈，陳教授表示未來會考慮建置專屬網站以開放軟

體型式將此產量監測方法公開，提供全球免費測試並回饋經驗，作為模式持續發展之基礎。

鑑於我國糧食作物監測調查主要以水稻為主，耕地使用情形與亞洲地區經濟體較相似，以下綜整本次研討會報告內容，針對中國大陸氣象衛星農業應用及目前已業務化運行的全國農業遙感監測系統(CHARMS)及台灣與相關亞洲重要稻米產區之農作遙感監測應用情形，臚列說明如下：

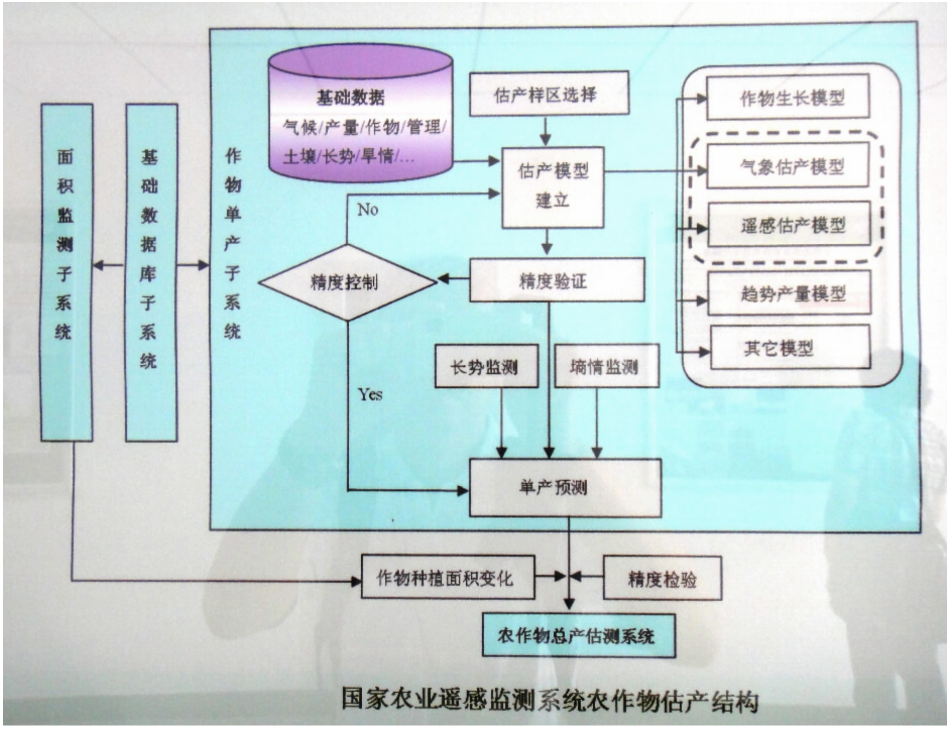
(一) 中國氣象衛星鳳凰 3 號 FY-3 農業應用

中國氣象衛星 FY-3 是由中國氣象局國家衛星氣象中心負責研發，屬極地軌道衛星(polar-orbiting)，接續第一代 FY-1 氣象衛星，FY-3 系列已自 2008 年成功發射 FY-3A 及 FY-3B 兩顆氣象衛星，搭載有 VIRR(Visible Infrared Scanning Radiometer 可見紅外光掃描儀，解析度 1.1km)和 MERSI(Medium Resolution Spectral Imager 中解析度光譜影像儀，解析度 250m)兩種與農業監測有關之感測器，其觀測能力相似於 NOAA/AVHRR、EOS/MODIS 及 ENVISAT/MERIS。大量的氣象資料可透過中國氣象局衛星氣象資料分送中心網站 CMACast，以近即時取得，系統亦已連結全球地球觀測系統提供全天候三維多光譜定量資料。該等氣象資料已產製植被生長監測、植被乾旱監測及地表溫度監測(如 snow cover map)等資料產品，已規劃近期可提供 APEC 經濟體成員應用。

(二) 中國國家農業遙感監測系統(CHARMS)

國家農業遙感監測系統(CHARMS)是一已業務化穩定運行超過 10 年的監測系統，係由大陸農業部農業信息技術重點實驗室自 1998 年起發展農情、農業災害及農業資源等三大領域遙感監測工作，目前每月 1 次監測全國主要作物小麥、玉米、水稻、大豆、棉花等及草地之作物面積變化、土壤濕度、作物生長勢、產量（單位產量及總產量）及主要農業災害等，相關動態監測信息依國家農情發佈日曆定期提供至農業部，該系統亦被納為政府間國際地球觀測組織（GEO）向全球推廣的農作物遙感監測系統之。

下圖為主要農作物產量預測工作流程圖

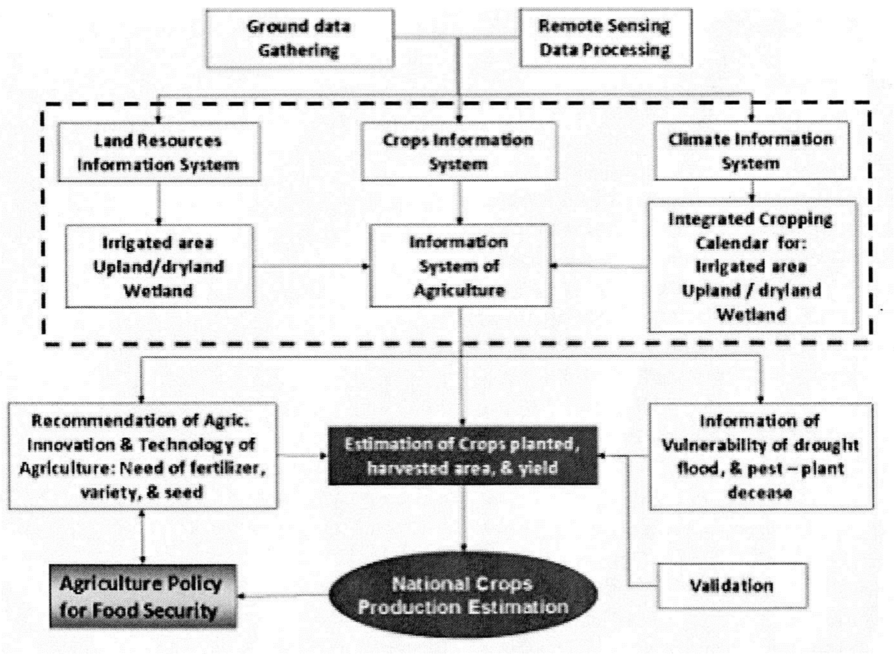


該系統以 MODIS 影像爲主要數據源，整合了氣象估產、遙感估產、作物生長模擬等各類估產模型，發展爲適合當地複雜國情的監測系統，相關關鍵技術包括利用 MODIS NDVI/EVI 時間序列資料提取水稻物候資料；利用 ACRM (A Two-Layer Canopy Reflectance Model) model 和 MODIS 反射值獲取葉面積、葉綠素 A、B 及作物含水量等植生指數，及建立 county 等級均質估產區，帶入作物生長模型據以估算作物產量。

(三) 印尼空間稻作生長監測及產量估測

印尼水稻面積廣大約有 8.1 百萬公頃，目前水稻生產調查方式有 2 種，一種傳統上由農業統計局統計各行政區資料之總計，另一種是”Ubinan”調查（樣本田面積大小 2.5m *2.5m)，係由地方單位官員於收穫前每月訪視樣本農戶進行問卷調查，並由農戶直接量測樣本調查單元提供相關生產數據。印尼政府因應永續糧食安全議題，爲快速、客觀掌握稻作生產資訊，已規劃利用衛星資料進行作物監測及產量預測，將由目前正由該國農業部農業研究發展署(IAARD)及所屬農業土地資源研究發展署(ICALRD)合作進行的監測系統擴大爲業務化運行系統。該系統採用光學及 SAR 衛星資料，整合氣象資料及作物曆發展，規劃之農業土地資源及作物國家資訊系統（National information system of Agriculture Land Resources and

Crops(food,Easate, and Horticulture Crops））架構如下圖。此外，印尼近年亦積極參與作物監測國際合作研究計畫，如 Asia Rice-GEOGLAM, SAFE-APRSAF, RIICE 等。



National information system of Agricultural Land Resources and Crops (Food, Estate, and Horticulture Crops)

(四) 菲律賓水稻及農漁業損失遙感應用

菲律賓水稻生產調查目前仍由農業統計局每季以傳統地面調查方式進行，調查統計至省級及全國。Eduardo Jimmy P.Quilang 博士報告菲國正由國際稻米研究中心(IRRI)與菲國水稻研究中心攜手合作，已展開系列水稻遙感應用研究，包括採用多時段 RADARSAT 影像融合技術估算水稻面積、繪製分布圖及預估產量；採用 ASAR（ENVISAT ADVANCED SYNTHETIC APERTURE RADAR）影像辨別作物類別和繪製稻田生態系統，由於試驗成效顯著，菲國政府已決定將逐年逐步推展至全國。另外，該國農業部 Xerxees R. Remorozo 博士報告菲國已依每月份災害建立不同災害類型資料庫，並利用 GIS 加以統計分析及繪製空間分布，未來擬利用開放軟體 DesConsultar 建置災害管理系統 Disaster Information Management System(DIMS)。

(五) 泰國農作生產及預測

為提升農業生產競爭力，泰國政府利用衛星影像分類製作土地使用圖及土地使用變遷情形以進行農業生產區調整，對不適合種水稻區域，鼓勵農民

與甘蔗工廠契作種植甘蔗，情形類似台灣正在推動之農田耕作制度調整；另泰國政府已有農作面積預測模式，規劃 2013 年開始啓動應用遙測技術於農作估產。

（六）越南農作物面積統計及土地利用分布製圖

越南水稻生產估測目前仍是由基層調查統計而成，有關遙測應用，部份研究使用 MODIS 影像之 NDVI 及 RVI(Ratio Vegat6ion Index)指數於土地覆蓋製圖；ENVISAT ASAR 影像於水稻生產監測；亦有使用 SPOT-5(2.5m) 影像依據分類系統產製比例尺 1:250000 之 Central Highland 全區農業土地使用圖(土地使用 14 類)，可進而分析土使使用變遷情形。

（七）台灣建立遙測農作面積調查體系之探討

由台灣代表(黃淑娟)簡報，題目：「A Discussion of Establishing a Remote Sensing-Based Survey System of Crop Fields」

介紹現階段我國行政部門對於稻作面積調查的策略，正朝積極建立遙測稻作面積調查體系發展，除利用航空照片外，另於航照缺漏地區依地區農耕特性，輔以衛星影像自動分類、UAV 影像人工判釋及地面現調等多元方式，以完整水稻種植分布調查及面積統計。

四、參訪行程

（一）農業部農業信息技術重點實驗室

參訪本次 APEC 訓練課程主辦單位--中國農業科學院農業資源與農業區劃研究所及所屬之農業部農業信息技術重點實驗室。中國農業科學院農業資源與農業區劃研究所成立於 2003 年，由中國農業科學院土壤肥料研究所與農業自然資源和農業區劃研究所合併成立，是國家級綜合研究機構。研究所研究範疇涵蓋有植物營養與肥料、農業遙感、區域農業發展與生態環境建設、現代土壤學和農業微生物資源與利用 5 大重點學科領域(下設 13 個研究室)，在農業遙感領域組建有 1 農業遙感與數字農業研究室，係爲農業部重點研發實驗室，並於 2011 年成爲農業部農業信息技術重點實驗室，建立有農業遙感野外綜合實驗站及 MODIS 衛星遙感地面處理系統工作平台，具備有業務化運行的全國農業遙感監測系統(CHARMS)，定期提供即時的農情信息服務

至農業部。現任中國農業科學院農業資源與農業區劃研究所所長為王道龍先生，農業信息技術重點實驗室主任為周清波研究員，亦為研究所副所長。

農業部農業信息技術重點實驗室以農業遙感的基礎理論及應用技術研究為核心，整合遙感、地理信息系統及 GPS 定位技術應用於農作物、農業資源、農業環境、農業污染和農業災害之監測與評估方法及其技術體系之發展，更致力於農業信息獲取、農業信息系統平台建設、農業信息處理及分析、農業系統模擬與虛擬農業、農業信息決策支援與信息服務，建置有農作物信息天地網一體化獲取體系，包含遙感獲取、地面獲取及網絡獲取三大類型，如下圖。

（二）北京長城及 798 文創藝術中心歷史文化之旅

參、心得與建議

一、心得

本次研討會訓練課程宗旨除在提昇各經濟體在遙感農作監測與產量預估領域的專業技術能力外，最重要的一部份即在凝聚經濟體間的共識，探討未來在資料、模式之分享及合作之可能性及策略，也正是呼應目前最熱門的全球觀測農業監測議題。APEC 經濟體不管是已開發或開發中國家，均理解到精確的農情信息，如作物種植面積、產量、生長條件等有助國家政策制定者制定或適時調整更為有效的農業政策，而這些信息皆源自對農業生產的監測，遙感(測)則是可以提供此客觀及科學監測數據的重要工具之一。因此，儘管遙感監測於此領域仍存在一些問題（如資料價格及普遍性、模式是否容易被複製與分享、資料準確性驗證等），但新型衛星數據及遙測科技的快速發展，各經濟體仍是由政府單位主導積極投入，並已有業務運行的成功案例。此外，亞洲各經濟體如日本、印度、泰國、越南、印尼、中國等亦均積極參與國際觀測組織。反觀我國，雖然國情不同，但各經濟體之遙測使用經驗，亦有足供我國參考之處。

二、建議

(一) 過去鑑於台灣農地破碎、耕地面積狹小及耕作複雜等特性，衛星遙測解析度的限制有其極限，遙測在農業領域之應用發展逐漸式微，然近年遙測科技結合地理資訊系統及全球定位系統，相關技術有飛躍的進步，建議政府農業部門、國科會及相關科研單位應重新重視並續予支持。

(二) 遙測影像方面，國際間注重多尺度多來源及多時段影像之整合應用，例如 SAR 影像及 MODIS 多時段光學影像之融合技術，在應用領域方面如作物面積調查、農林業資源調查、環境因子分析及防災等，目前我國林務局農林航空測量所積極引進 SAR 影像拍攝系統，其與國際間之發展趨勢吻合，未來在資料取得後如何應用於各領域，建議相關主管單位必須列為科技研究之重要項目。

(三) 台灣農業研究單位已累積相當豐富的農作物生長勢資料及模型，也應用資通訊技術開發「作物優質生產系統」，結合本會農業試驗所及各改良場的專家知識，整合土壤、氣象、病蟲害防治、肥料、稻作等資料庫，提供水稻栽種曆

服務，惟係提供地區性田間尺度資訊服務，建議應延伸擴大與遙測資料結合進行大面積的監測及產量預估，以獲取即時生產資訊。

(四) 全球氣候變遷影響糧食安全，各國均積極利用遙測具快速大面積監測農作面積及估測產量的特性發展遙測技術並投入地球觀測應用，我國更應主動參與此類相關地球觀測組織，藉此培育國內相關研究單位及組織團體，以利提升技術能與國際間發展接軌，並增加國際能見度。【按：我國已於 102 年度由國立中央大學太空及遙測研究中心及農委會農業試驗所名義加入 GEOGLAM 的前瞻計畫 JECAM「作物評估及監測聯合試驗」】

(五) 建議加強培養政府部門內相關領域專業人才，選派出國參加國際研討會，以利專業交流提升本國最先進之專業知識及能力，並落實推動於業務應用。

(六) 目前政府行政部門及研究單位未具有空間應用職系職缺，相關專業人才引進不易，影響此新興遙測技術在農業領域之應用及發展，建議農業部門應建議考試院儘速納入推動，並於未來積極進用，以提升農業部門的空間資訊技術應用能力。

附錄

1. 照片集錦
2. 研討會訓練課程
3. 簡報：「A Discussion of Establishing a Remote Sensing-Based Survey System of Crop Fields」
4. 墨西哥 ERMEX 衛星科技應用於農田管理簡冊

照片集錦

APEC 訓練班開幕式

APEC 訓練班團體照

台灣代表(黃淑娟)簡報情形

參訪中國農業科學院

參訪農業信息技術重點實驗室

實驗室－衛星接收資訊

研討會訓練課程

Training Course Program

Day 1

Session 1,	**Opening Ceremony, Chaired by: Prof. Xu Minggang**	
09:00-09:50	Welcome Speeches by: Prof. Tang Huajun, Vice president of CAAS, ATCWG Lead Shepherd Mr.Thanawat Sirikul, APEC Secretariat, Program administrator Mr. Sun Xiaodong, Director, Financial Ministry, P.R.China Ms. Wang Weiqin, Director of International Division, International Cooperation Department, Ministry of Agriculture, P.R.China Mr. Shi Wei, Deputy Director of Fourth Division, International Department, Ministry of Foreign Affairs, P. R. China	
09:50-10:20	Group photo and Tea Break	
Session 2	**Chaired by: Dr. Wu Wenbin**	
10:20-10:45	China-ESA “Dragon Program” Introduction	Prof. Li Zengyuan(China)
10:45-11:10	Impacts of Global Change on Food Production Systems in China	Dr. Wu Wenbin (China)
11:10-11:35	An Empirical Analysis of Land Use Change and Soil Carbon Sequestration in China	Dr. Li Man (USA)
11:35-12:00	Accurate Regional to Field Scale Yield Forecasting of Australian Sugar Cane and Peanut Crops Using Remote Sensing and GIS	Dr. Andrew James Robson (Australia)
12:00-13:30	Lunch	
Session 3	**Chaired by: Dr. Rizatus Shofiyati**	
13:30-13:55	Remote Sensing Applications for Rice in the Philippines	Dr. Eduardo Jimmy P.Quilang (Philippines)
13:55-14:20	Application of Remote Sensing Technology in Statistical Area and Land Use Mapping for Main Crops in the Central Highlands	Dr. Nguyen Thi Hong Anh (Vietnam)
14:20-14:45		Mr. Elar Timoteo Sifuentes Montes(Peru)
14:45-15:10	A Discussion of Establishing a Remote Sensing-Based Survey System of Crop Fields	Prof. Huang Shuchuan (Chinese Taipei)
15:10-15:30	Tea break	
Session 4	**Chaired by: Prof. Chi-Farn Chen**	

15:30-15:55	Future Trends of Chinese Food Security under Climate Change	Dr. Ye Liming(China)
15:55-16:20	City Development and Atmospheric Environment Change in Bohai Rim Region	Dr. Bai Linyan(China)
16:20-16:45	Crop Disease Monitoring by Remote Sensing	Dr. Huang Wenjiang (China)
16:45-17:10	MODIS-NDVI-Based Multi-crops Planting Areas Extraction and Crop Growth Monitoring	Dr. Huang Qing(China)
17:10-17:35	Remote Sensing of Snow with FY-3	Dr. Wu Shengli (China)
17:35-18:00	Summary for the first day	Dr. Li Man (USA)
18:30	**Welcome Reception, buffet**	

Day 2

Session5	**Chaired by: Dr. Andrew James Robson**	
08:30-08:55	Application of Remote Sensing and GIS Technology on Crops Productivity in Malaysia with Paddy and Coconut Is the Main Focus.	Dr. Syed Hakim Syed (Malaysia)
08:55-09:20	Remote Sensing Analysis with SPOT Images and Unmanned Aerial Vehicle (UAV)	Dr. Noemí López González (Mexico)
09:20-09:45	Spatial Analysis for Supporting the Risk Analysis and Making Decision in the Release of GM Crops into the Environment	Dr. Jorge Alcantara Delgado (Peru)
09:45-10:10	Mapping Banana Plants to Facilitate Eradication of Banana Bunchy Top Virus	Dr. Kasper Johansen (Australia)
10:10-10:30	Tea break	
Session6	**Chaired by: Dr. Márton DEÁK**	
10:30-10:55	Enhancing the Agricultural and Fisheries Damages and Losses Assessment during Disasters using IT: GIS, Data ware housing and Remote-sensing	Dr. Xerxees R. Remorozo (Philippines)
10:55-11:20	Using Space Technology and Remote Sensing in Chilean Agriculture	Dr. Eugenio Gonzalez Aguiló (Chile)
11:20-11:45	Crop and Pest Modeling in a Climate Change Context	Mr. Henry Saul Juarez Soto (Peru)
11:45-12:10	RS and GIS Application for Economic Crop Zoning in Thailand	Dr. Karika Kunta(Thailand)
12:10-13:30	Lunch	
Session 7	**Chaired by Mr. Henry Saul Juarez Soto**	
13:30-13:55	Quantitative Remote Sensing Research and	Mr. Yang Guijun (China)

	Application in Precision Agriculture	
13:55-14:20	Land Surface Temperature Retrieval from Thermal Remote Sensing Data	Dr. Gao maofang (China)
14:20-14:55	Sub-pixel Vegetation Analysis of EO-1 Hyperion Satellite Images	Mr. Márton DEÁK (Hungary)
14:55-15:20	Frost Monitoring with Low Resolution Satellite Data	Mr. Fan Jinlong (China)
15:20-15:40	Tea break	
Session 8	**Chaired by Dr. Li Man**	
15:40-16:05	Crop Yield Estimation in China Agriculture Remote Sensing Monitoring System (CHARMS)	Dr. Ren Jianqiang(China)
16:05-16:30	Investigating the Influence of Climate and Socio-economic Factors on the Spatial Temporal Variability of Soil Organic Matter	Mr. Cao Qiwen(China)
16:30-16:55	Regional Crop Yield Estimation Based on Remote Sensing Data Assimilation Technology	Dr. Jiang Zhiwei(China)
16:55-17:20	Estimation of Crop Evapotranspiration Based on Remote Sensing	Dr. Sunliang(China)
17:20-17:45	Spatial Analysis Tools of ArcGIS in Land Use Analysis	Dr. Li Zhibin (China)
17:45-18:10	Summary for the Second day	Dr. Li Man(USA)

Day 3

Session9	**Chaired by: Dr. Kasper Johansen**	
08:30-08:55	A Phenology-Based Approach for Rice Crop Monitoring	Prof. Chi-Farn Chen (Chinese Taipei)
08:55-09:20	Indonesian Paddy Crop Growth Monitoring and Yield Estimation From Space	Dr. Rizatus Shofiyati (Indonesia)
09:20-09:45	Crop Suitability Detection by Remote Sensing and GIS	Dr. Yu Shikai(China)
09:45-10:10	Crop Production Forecasting in Thailand	Dr. Pornpun Hensawang (Thailand)
10:10-10:30	Tea break	
Session10	**Chaired by: Dr. He Yingbin**	
10:30-12:00	Presentation of Training Course Findings and Discussion, Summary Report Initiation	All the participants
12:00-13:30	Lunch	
Session11	**Chaired by: Dr. HE Yingbin**	
13:30-14:00	Future Plans and Activities	All the participants
14:00-15:00	Training Course Evaluation	

15:00-16:00	Closing Remarks	All the participants
Day 4		All the participants
08:00-17:30	Field observation	
	End of Training Course	

簡報：「A Discussion of Establishing a Remote Sensing-Based Survey System of Crop Fields」

A Discussion of Establishing a Remote Sensing-based Survey System of Crop Fields

Agriculture and Food Agency
Council of Agriculture,Chinese Taipei
August, 2013

1

Outlines

- ***General Information of Chinese Taipei***
- Study Background
- Challenge to RS Application on Paddy Field Survey
- Current Approach
- Alternative Approach
- Proposed Paddy Field Survey System (Based on Multi-Stage Remote Sensing)
- Summary

2

General Information

Size:370 km long and 142 km wide
Area :36,000 square kilometers
Mountainous or hilly area: ¾
Cultivated land: ¼ ~ 810,000 hectares
Population: 23 millions
Ambient temperature:
22 °C in the north
24.5 °C In the south
Rainfall: 2,500 millimeters
located in the Western Pacific between Japan and the Philippines

3

Current Status of Agricultural Developments

- Agriculture accounted for more than 30% of GDP in the 1950s but fall only to 1.72% in 2011. However, the contribution was 11% if the related primary, secondary and tertiary industries are included. This shows that agriculture remains an important sector in the overall economy of Chinese Taipei.
- Agriculture has shifted its role as the supplier of food in the past to the current multi-function role in food security, rural village development and ecosystem conservation.

4

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Study Background

- Estimating the annual yield of crops is one of the most important missions of all the food authorities in the world.
- The demand of an efficient approach to investigate and estimate crops yield in a large scale, initiates the usage of remote sensing techniques.
- The Agency has utilized the aerial photos of rice paddy and employed the techniques to estimate the rice area since 1980.

6

1

Study Background (cont.)

- Photogrammetric interpretation is a labor-intensive work which processing some 5,000 photos for one crop season.
- Using satellite imagery becomes an alternative.
- FORMATSAT-2 visits everyday and covers a large area that promises an economic and effective solution.
- This presentation summarizes the results of several research projects to discuss the technologies of paddy field survey system based on aerial and satellite imageries.

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8

What is RS?

- From a general perspective, remote sensing is the science of acquiring and analyzing information about objects or phenomena from a distance.
- By definition, RS contains collecting images of objects through satellites, aircraft and UAVs (unmanned aerial vehicles).
- Images, taken by FORMOSAT-2 or French SPOT, have the advantages of large spatial coverage and frequent visit rates (pass Chinese Taipei every day).

9

Characteristics of Wild Used RS images

Image Source	Appliance	Major Application	Advantage	Disadvantage
Hi-resolution Satellite image	FORMOSAT-2/SPOT-5	■Large Area observation	■Large Area Coverage ■Daily revisit ■Overall monitoring	■Cloud affection
Aircraft	Man-carrying Fixed wing aircraft	■Large Area observation ■accurate Survey	■Hi-resolution imagery ■focused monitory	■Small imagery coverage ■Weather affection

10

Problems Encountered

- Precise paddy rice mapping is necessary not only for the national food security but also for the agricultural subsidy policies.
- The cultivated area of each paddy field is concerned with the farmers' rights of subsidy, the required accuracy of investigation is 95%.
- Can the RS technologies be used to identify paddy fields Precisely , especially in a highly fragmented area ?

11

Accuracy from aerial photo interpretation via satellite image classification

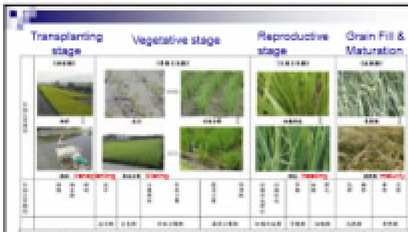
- The accuracy of manual interpretation based on aerial photos can reach up to 96% or higher.
- Due to limited spectral resolution, satellite images of paddy fields are easy to be confused with those of other types of vegetation such as grass or timber, which makes automatic interpretation of paddy fields based on satellite images less accurate than manual interpretation based on aerial photos.

12

Basic Information about Rice Growing

- 1st crop (spring~summer for 110~140days)
- 2nd crop (Summer~Fall for 98~110days)
- Planting sequence from south to north

Area	1st crop season	2nd crop season
Yilan	early Mar. – Mid. July	N/A
Taipei	late Mar. – early Aug.	Mid. Aug. – late Dec.
Hsinchu	Mid. Mar. – late July	Early Aug. – early Dec.
Taichung	Early Mar. – Mid. July	Early Aug. – early Dec.
Chiayi & Tainan	Early Feb. – late June	Early Aug. – mid. Nov.
Kaohsiung & Pingtung	Early Feb. – mid. June	Mid. July – late Dec.
Taitung	Early Feb. – early July	Early Aug. – early Dec.
Hualien	Mid. Feb. – Mid. July	Early Aug. – Mid. Dec.



- During the rice growth period , the land cover changes from plowing land to growing seedlings (water body) to tillering (vegetation) to yellow ripening (vegetation) to harvest (bare soil).
- RS spectral reflectance also changed on different stages and thus can be a basis for classification.

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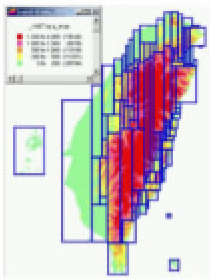
Current Approach: Aerial photo Interpretation

- Paddy parcels are identified based on aerial photos , the main procedures including:
  - ✓ Make the Flight Plan
  - ✓ Manual Aerial photo Interpretation
  - ✓ Digitize the results
  - ✓ Produce Paddy Rice Maps

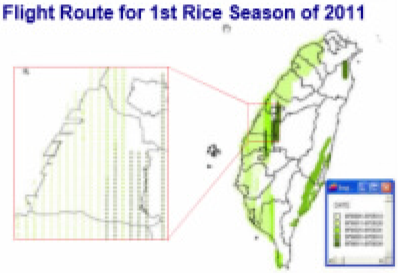
Make the Flight Plan

Make the flight plan base on area of interest and Terrain information

Need temporal consideration



Flight Route for 1st Rice Season of 2011



3

Aerial Photos in the Same Flight Line

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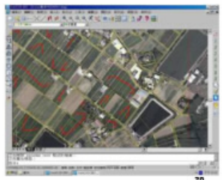
Aerial Photo Identification

use two consecutive photos as stereo pairs to identify land uses

Digitizing Rice Paddies



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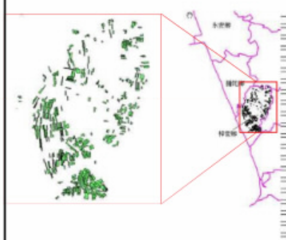
Produce Township Paddy Map



AREA	PERIMETER	SECTION
857.606	128.217	150040
260.36	82.376	150040
1,835.94	183.372	150040
726.2	128.16	150040
688.585	110.38	150040
1,875.9	240.247	150040
439.797	95.5559	150040
3,493.25	246.157	150040
1,412.5	178.138	150041
3,871.12	272.068	150041
1,711.36	222.102	150040
121.771	46.4888	150040
1,579.81	206.531	150041
611.667	102.944	150040
124.164	48.3972	150041
1,283.55	143.982	150041
3,894.51	279.32	150040
1,178.96	138.228	150040
287.855	81.0991	150041
558.676	102.791	150041

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- General Information of Chinese Taipei
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Alternative : Satellite Images Classification

- An automated mapping methods identifies paddy parcels based on multi-temporal satellite images and GIS information , the main procedures including:
  - ✓ automatic selection of paddy-field training sites
  - ✓ image classification
  - ✓ error analysis
  - ✓ human-machine interactive interpretation

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Automatic Selection of Paddy-Field Training Sites

- Automatically select training sites by the criteria of being paddy fields for 10 consecutive years from historical paddy-field database using GIS map layer overlapping.

(A) Original Paddy | (B) Paddy growing rice 10 year continually | (C) Paddies not growing rice for 10 year continually

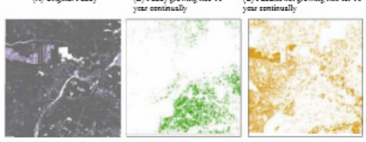

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Image Classification

- Image classification is based on land parcels.
- Method of maximum likelihood and bayesian classifier are used in classification, with texture information used to improve accuracy of classification.
- Timing of cropping in the subject area is essential, which is used to set the dates of satellite images and to choose the best spectral reflectance of paddy fields for optimal results.

Rice Planting & Reaping Progress Chart

Image selected from different growing stage

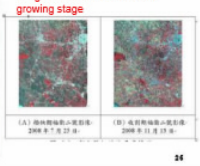

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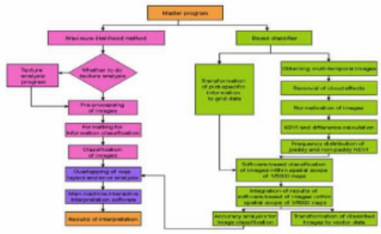
Image Classification (cont.)



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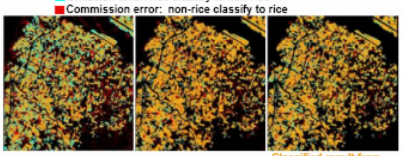
- Image pixels are classified as paddy-field and non-paddy-field based on a probability model.

Rice classify to rice
Non-rice classify to non-rice
Omission error: rice classify to non-rice
Commission error: non-rice classify to rice



Classified result from PCA (Principle Component Analysis) | Classified result from multi-temporal images | Classified result from multi-temporal image +edge dectection

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Error analysis method

- Error Type1: the probabilities of being rice and non-rice are too close
- Error Type2: the probability of being rice or non-rice is too low
- Adjust the threshold to get the better classification result
- The objective is to decrease the extra effort needed

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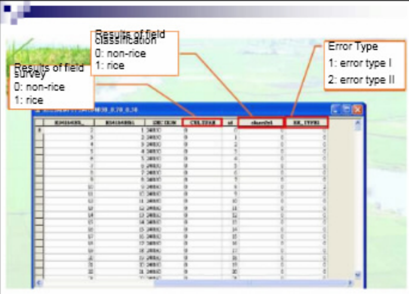

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Man-Machine Interactive Interpretation

- Applicable when there are aerial photos available
- For ambiguous interpretation of images (such as probabilities of 0.4-0.6) or plots with too low probabilities to be paddy fields, aerial photos are used for double checking.

Man-Machine Interactive Interpretation (cont.)

Visual interpretation and operation

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Feasibility Evaluation

- Empirical studies have been made on various satellite images and classification methods for different areas. The results are verified by aerial surveys.
- The overall accuracy for satellite image interpretation of paddy fields ranges from 80% to 95% depending on areas and qualities of the images.
- The percentage for omission & commission errors are considerably high, implying the need for manual interpretation and ground surveys.

		Taoyuan	Hsinchu	Taichung	Changhua	Changhua Refine training site	Changhua Refine training site + Correct small parcel's data	Changhua Refine training site + Correct small parcel's data + error analysis & interactive interpretation
RICE	Producer's Accuracy	73.38	74.04	65.14	60.1	69.83	76.76	84.95
	User's Accuracy	74.23	72.44	89.37	81.37	86.00	82.78	91.83
NON RICE	Producer's Accuracy	98.13	97.33	98.67	96.22	97.39	97.11	98.61
	User's Accuracy	98.85	97.54	94.17	89.77	93.88	95.05	97.36
Overall Accuracy		96.47	95.32	93.69	88.43	91.93	93.59	96.40
K		0.719	0.704	0.793	0.622	0.726	0.761	0.862

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Some Observations on The Evaluation

- Cloudy Weather affects the image quality
- Misacted multi-strip images create difficulties on interpretation
- Cadastral boundaries of land parcels do not conform with physical boundaries to some extent
- Small-sized and fragmented farmland causes mixed pixels
- Farming habits is changing, and It is hard to define a homogenous area for growing paddy rice

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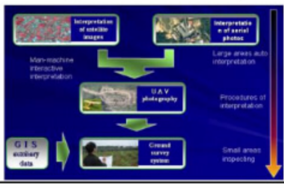
proposed paddy field survey system (based on multi-stage remote sensing)

- Satellite images are used for automatic interpretation for large areas and high-resolution aerial photos for small areas or ground surveys are used to remedy omitted or mistaken interpretation.



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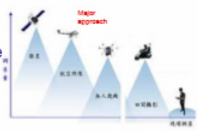
Adopted Procedures

- For large areas with aerial photos, use aerial photos and/or satellite images to obtain distributions and estimate area of paddy fields.
- For large areas with no aerial photos, undertake satellite image-based analysis to obtain distribution and RS-measured total area of paddy fields as a basis for further estimation.
- For small areas with dense distribution of paddy fields, use UAV photography to undertake quick and effective surveys.
- For small areas without dense distribution of paddy fields, ground surveys are economical and efficient.



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Adopted Procedures (cont.)

- If aerial photos are not available, UAV investigations (for rice dense area) or field surveys (for non-rice dense area) using PDA-based system are applied.

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Summary

- Due to the constraints, using only one survey method currently can not achieve the mission of investigation covering the entire island and get the precise mapping data.
- Since the aerial photography technology has been taken to survey paddy fields, the weather and aircraft mechanical issues have happened quite often.
- To resolve the problems, a multi-stage RS survey system is introduced to implement large-scale automatic interpretation of paddy fields based on FORMOSAT-2 or SPOT satellite images and supported by use of UAV images and ground surveys.

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Summary (cont.)

- The advantage of the multiple-stage RS approach is the capabilities to target the confusing plots for further actions, such as: man-machine interactive interpretation, ground surveys etc. Thereafter, the higher degree of accuracy can be obtained and the operational cost can also be decreased.
- This system may have the potential for other agricultural applications.

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End of presentation.

Thank you!

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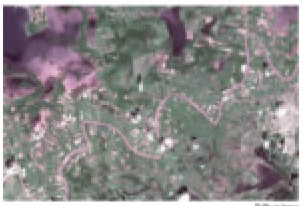
ERMEX
ESTACIÓN DE RECEPCIÓN MÉXICO

Satellite technology
for field management

Agrifood and Fisheries Information Service

SEDENA SAGARPA



The station was designed for receiving the signal of the most powerful earth observation satellites, which strategic information is managed by mexican highly specialized technicians who process the images and design accurate geospatial applications. The National Defense Ministry (SEDENA) facilitated its installation and protection within the XXII Military Area. With this strategic alliance, the ERMEX NG had been strengthened.

Acquisition

Mexico New Generation Reception Station

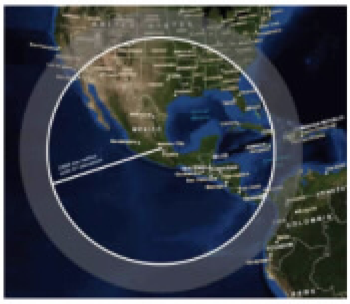
What is ERMEX NG?

The Mexico New Generation Reception Station (ERMEX NG) is the technological infrastructure of the Ministry of Agriculture, Livestock, Rural Development, Fisheries and Food (SAGARPA) that makes possible to observe the Mexican territory from outer space: its cities, fields and seas.

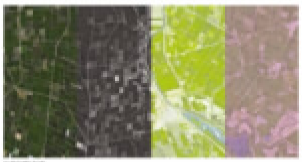
Each SPOT and Pleiades satellites criss-cross the national territory twice a day.

Data fallen from the sky:
Technological advantages from the satellites that ERMEX NG captures

- Generation of national mosaics (full territory scanning).
- Ability to capture same areas from different angles.
- Minimum time of response to program urgent images: four hours prior.
- Resolution: Up to 1.5 meters.
- Radiometric resolution: 12 bits.
- Coverage: 2,300 to 2,500 kilometer radius.

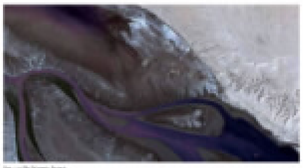


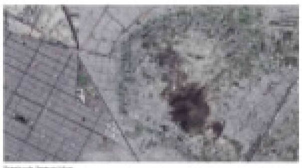
- Telemetry channel: 270 Mb.
- Annual capture capacity: 20 thousand images.
- Panchromatic bands: green, red, blue and near-infrared.
- Directly produces orthorectified and color images.
- It allows the acquisition of stereo and tri-stereo images in the same pass.
- Related satellites: SPOT and Pléiades.



ERMEX NG administration

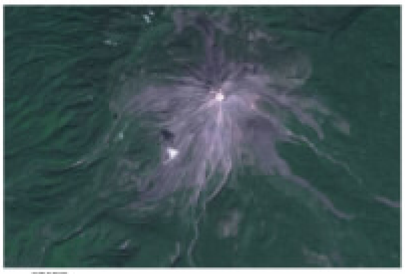
The Agrifood and Fisheries Information Service (SIAP) of SAGARPA is the institution responsible for the administration and operation of the ERMEX NG antenna, besides being a satellite image provider for agencies from the three orders of government, for research centers and public universities who can perform high impact projects without additional costs for the country.





User service

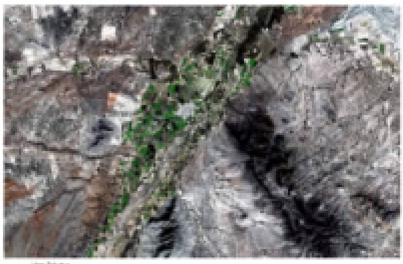
SIAP receives an average of 70 thousand requests each year through authorized operators from the user information institutions, among which stand SAGARPA itself –through SIAP and the Support and Services for Agricultural Trading Agency (ASERCA), mainly–, the National Defense Ministry –the government instance that also protects the ERMEX NG facilities–, the Navy Ministry and the Government Ministry. The most demanded images are from the agricultural field of Mexico.

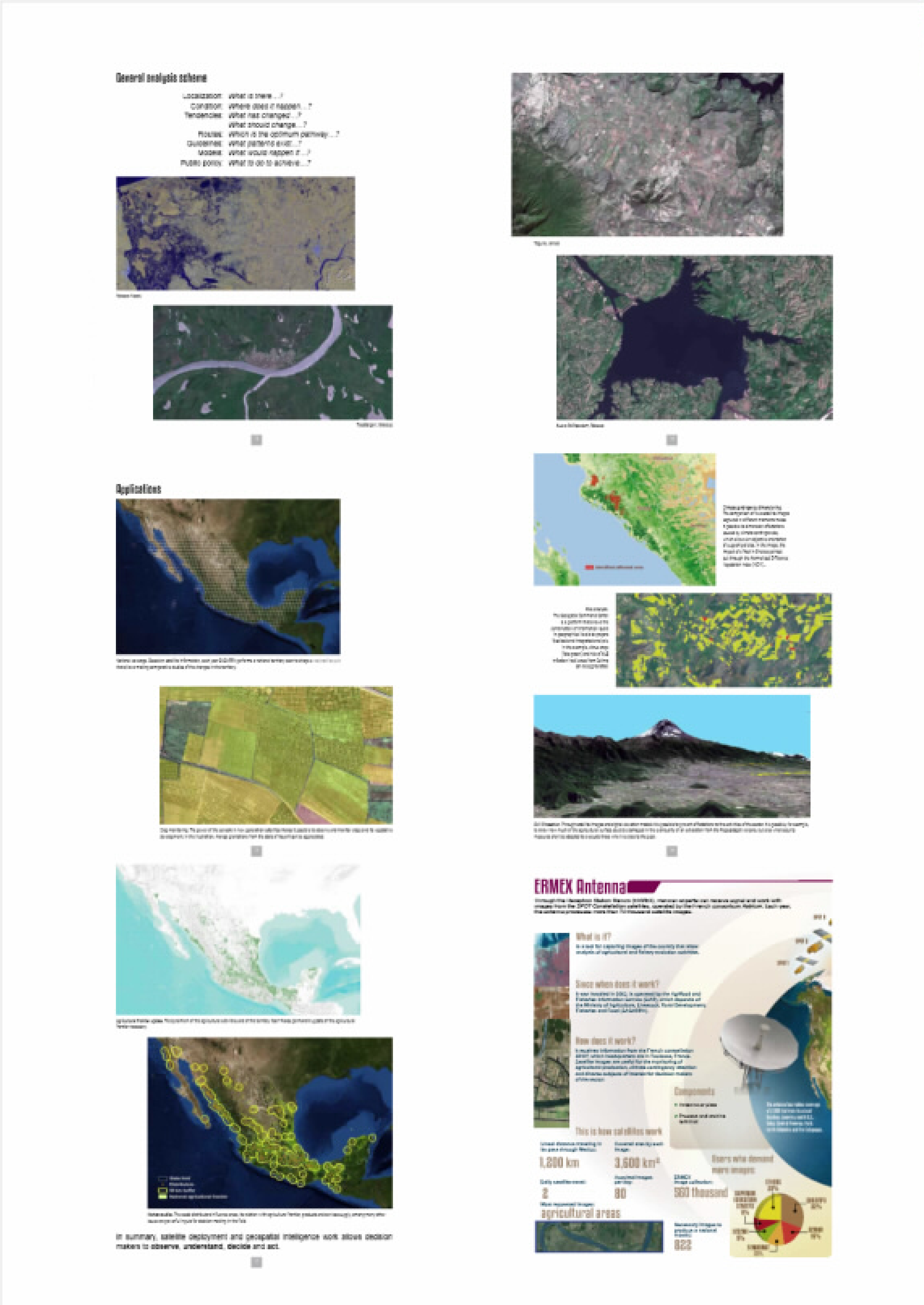


Applications

Geospatial Command Center

The Geospatial Command Center is a unique platform that allows the combination of information layers. It is operated by an expert link distributed throughout the country and is responsible for image exploitation by geospatial analysis to generate studies for public policy design and implementation.




General analysis scheme
Localization: What is there…?
Condition: Where does it happen…?
Tendencies: What has changed…?
What should change…?
Routes: Which is the optimum pathway…?
Guidelines: What patterns exist…?
Models: What would happen if…?
Public policy: What to do to achieve…?
Applications
In summary, satellite deployment and geospatial intelligence work allows decision makers to observe, understand, decide and act.
ERMEX Antenna
What is it?
Since when does it work?
How does it work?
Components
This is how satellites work
1,200 km
3,600 km²
2
80
560 thousand
agricultural areas
822
Users who demand more images

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